

# Common origin of superluminal neutrinos and DAMA annual modulation

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We suggest that the recently observed superluminal neutrino propagation observed by OPERA may have an environmental origin that can simultaneously explain the DAMA/LIBRA annual modulation. Our proposal can be unambiguously tested by the prediction that OPERA will also observe an annual modulation in the speed of neutrinos. Experiments geographically distant from Gran Sasso will however not be able to observe these effects. We do not rely upon any violation of Lorentz symmetry except for spontaneous breaking of translational invariance. We discuss implications for the CRESST experiment, also located at Gran Sasso.

In a *tour de maitre* of striking disproportions, the physics world and indeed fragments of the general public have been astonished by the long-awaited overthrow of relativistic despotism implied by the OPERA experiment's recent detection of muon neutrinos traveling faster than light between CERN and Gran Sasso National Laboratory (LNGS) [1]. Before declaring such a victory however, we should be careful to rule out more mundane explanations such as the one proposed in the present paper (see below). It is intriguing that at the same time (plus or minus ten years) the DAMA/LIBRA experiment, seemingly coincidentally located at Gran Sasso, has been reporting equally convincing evidence for the annual modulation of unidentifiable backgrounds in their detector [2], which could include the impotent interactions of dark matter particles blowing through their apparatus at highly subluminal speeds.

The dramatic discovery of OPERA has been met with a remarkable paucity of plausible explanations or criticisms from the theory community [4]-[63]. In a remarkably cunning bit of sophistry, Cohen *et al.* [32] argued that superluminal neutrinos would lose too much energy via decay to be consistent with the observation, but this hypothesis is clearly ruled out by the observations of ref. [64]. Similarly ref. [10] has pointed out theoretical difficulties for superluminal propagation, but their analysis is not self-consistent since the authors clearly knew about the experimental results before they were reported, showing evidence for superluminal propagation of information.

Our observation is inspired by the curious proposal of ref. [5], which claimed that an extra graviton polarization sourced by the earth could account for the superluminal motion. This claim seems absurd since as is well known, passage through a gravitational potential can only make particles travel slower, not faster than light<sup>1</sup>, unless the source has unusual properties. Here we posit the existence of a source that violates the weak null energy condition (WNEC),<sup>2</sup> which is also a requirement for sourcing traversible wormhole solutions in general relativity [65]. A wormhole with one end located in close proximity to LNGS would be consistent with the explanation of ref. [5], while removing the objections to a power-law behavior for the energy-dependence of the superluminal effect, since the experiments which would seemingly contradict this hypothesis [66] were not located at LNGS.

Emanating from this wormhole will be a number of objects which do not get very far inside the Gran Sasso Mountain, but in addition we expect a contribution to the dark matter wind that can have a significant impact on the annual modulation observed by DAMA. This observation is especially timely since it has been recently pointed out that there is a strong correlation between the DAMA observations and the annually modulated flux of atmospheric neutrinos [67]. It is important to notice that the extra component to the dark matter wind emanating from the wormhole will also be annually modulated by the stretching of the wormhole over the course of a year (except in the unlikely event that the other end of the wormhole lies along the axis of rotation of the earth's orbit). We believe that this effect should exactly compensate the atmospheric muon background not taken into account by DAMA's analysis, meaning that their net modulation comes from the ordinary (non-wormhole) component of the dark matter wind. Here we have some connection with the proposal of ref. [28], which fantasized the propagation of sterile neutrinos mixing with  $\nu_\mu$  in warped extra dimensions; our wormhole too could be traversing in part the extra dimensions. However unlike ref. [28] we do not need to assume that the mixing angle of  $\nu_\mu$  with the sterile neutrino is simultaneously both large and small.

Unlike other proposed explanations of the OPERA anomaly, our proposal is fully testable, since the annual distortions of the wormhole will change the gravitational potential transmitted by the extra graviton polarization, leading to annual modulations in the  $\nu_\mu$  velocity anomaly of one part in  $10^{10}$ , which could be measured by OPERA given a sufficiently long period of data collection and analysis. In addition, there are implications for the CRESST experiment which is also located at LNGS. These and other details of the present analysis, complete with equations, will be discussed in a forthcoming publication [68] now that we have laid claim to our idea.

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<sup>1</sup>We thank Dr. G.D. Morose for charming diatribes on this subject

<sup>2</sup>We remind the reader that “null” in the context of WNEC modifies “condition” rather than “energy”

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